June 20, 1961 H. MILLIKEN 2,988,887

VAPORIZING OIL BURNER

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Fig. 2

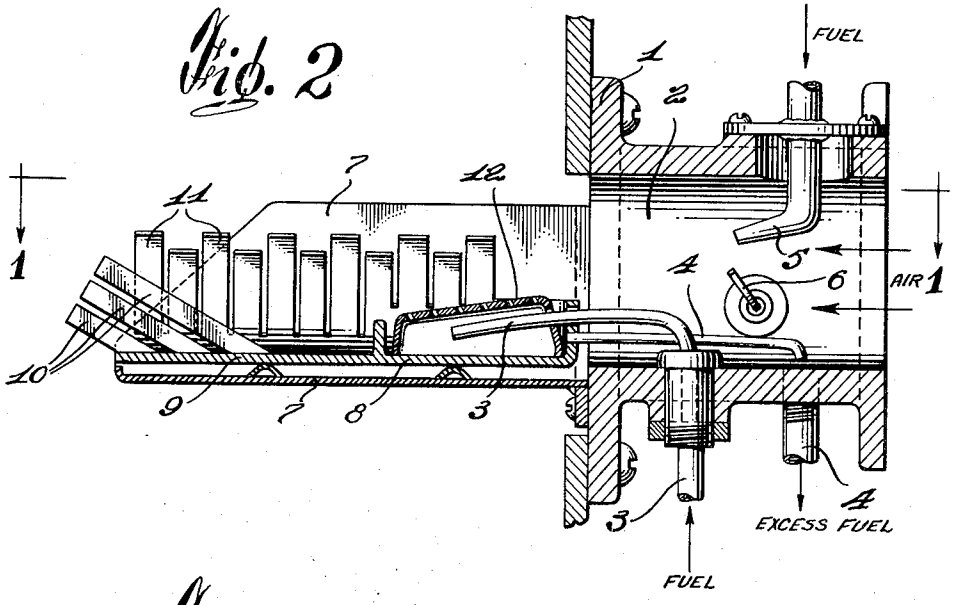


Fig. 1

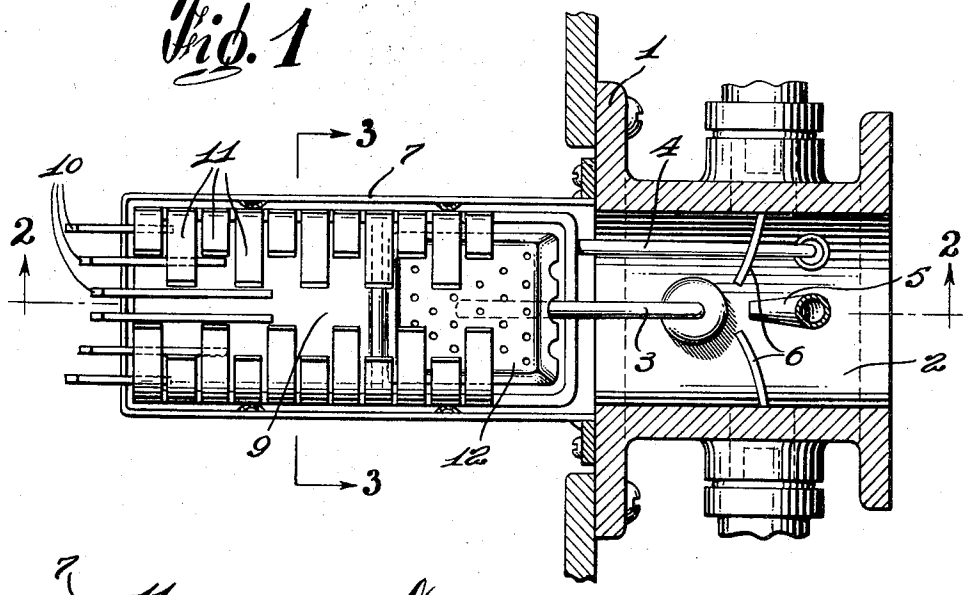
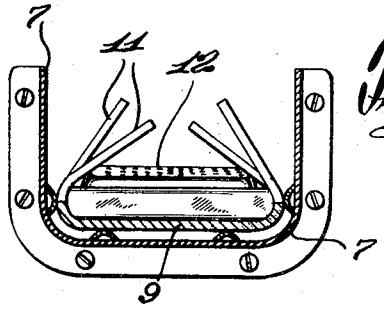


Fig. 3



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VAPORIZING OIL BURNER

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6 Sheets-Sheet 2

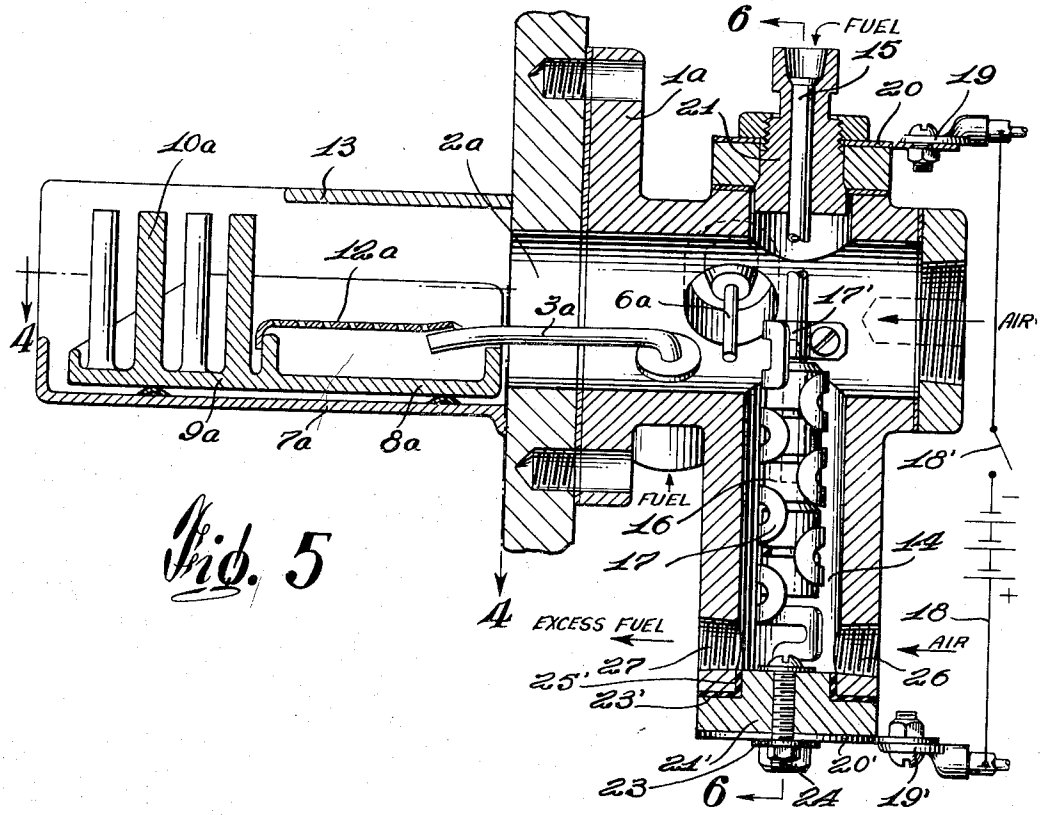

Fig. 5

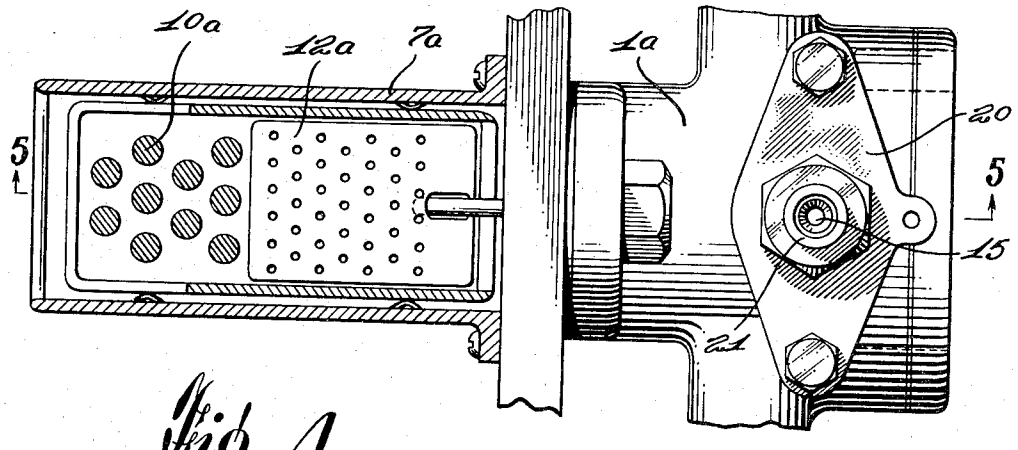

Fig. 4

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VAPORIZING OIL BURNER

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Fig. 7

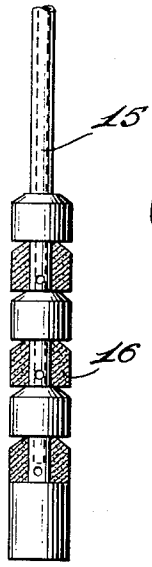


Fig. 6

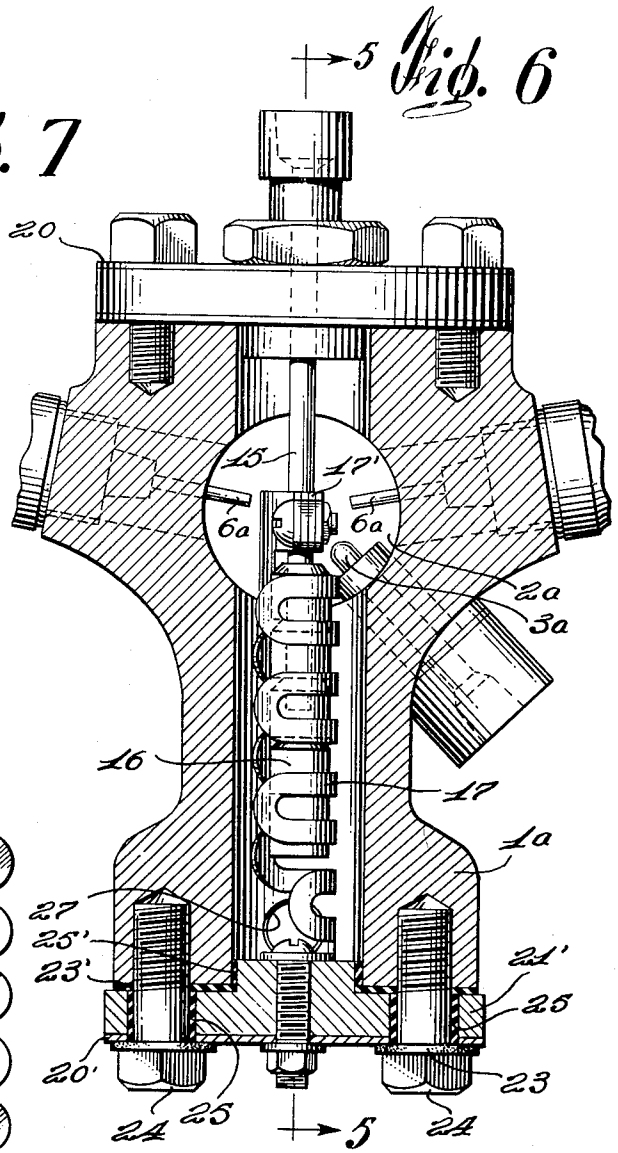
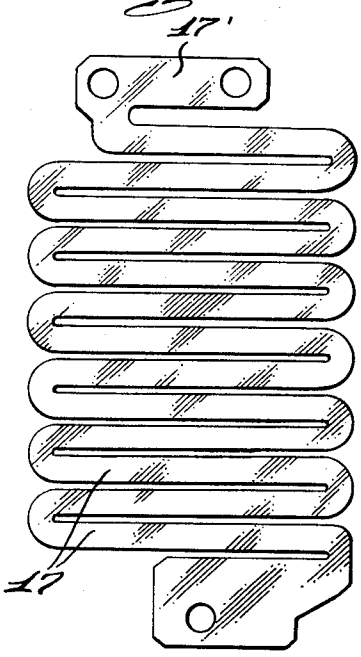


Fig. 8



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6 Sheets-Sheet 4

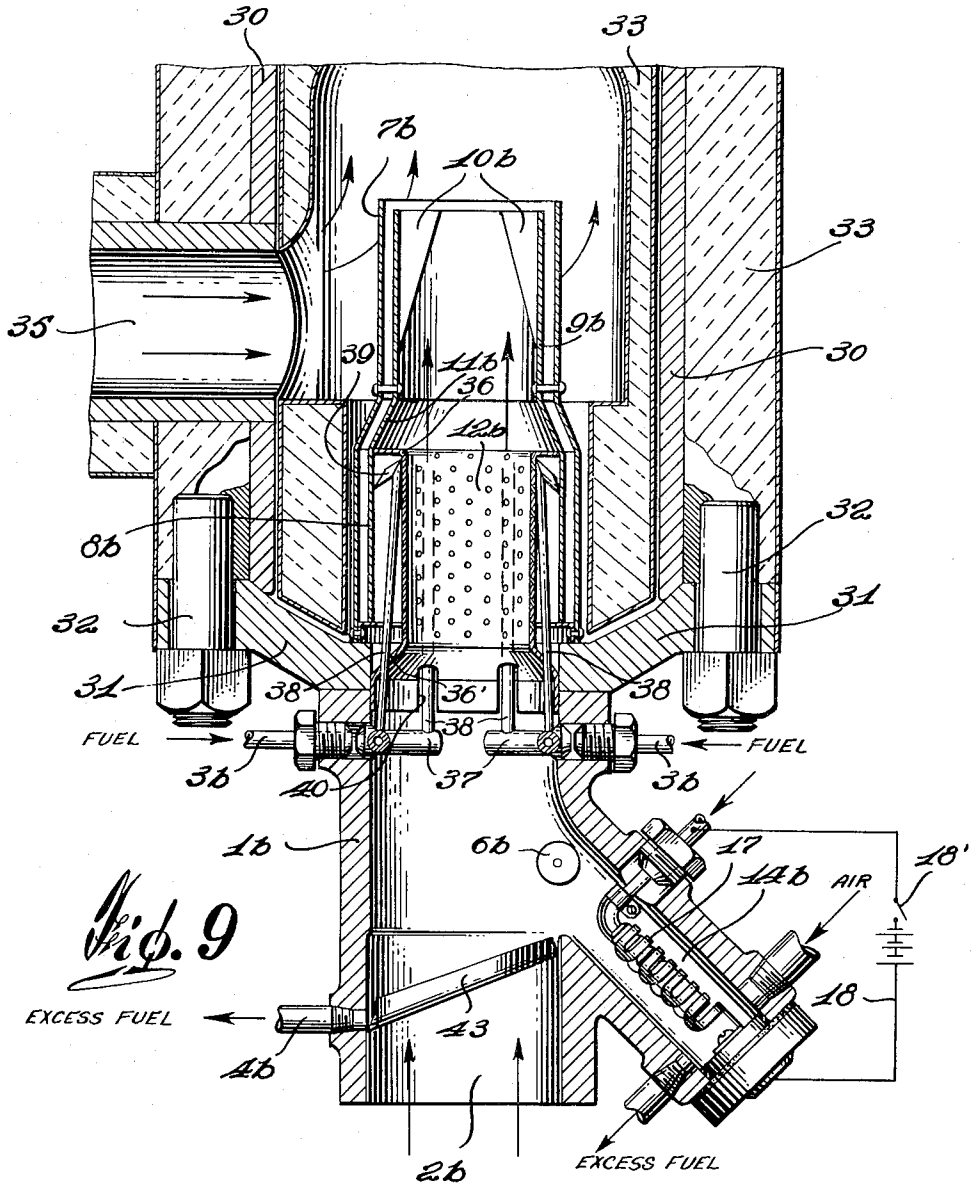

Fig. 9

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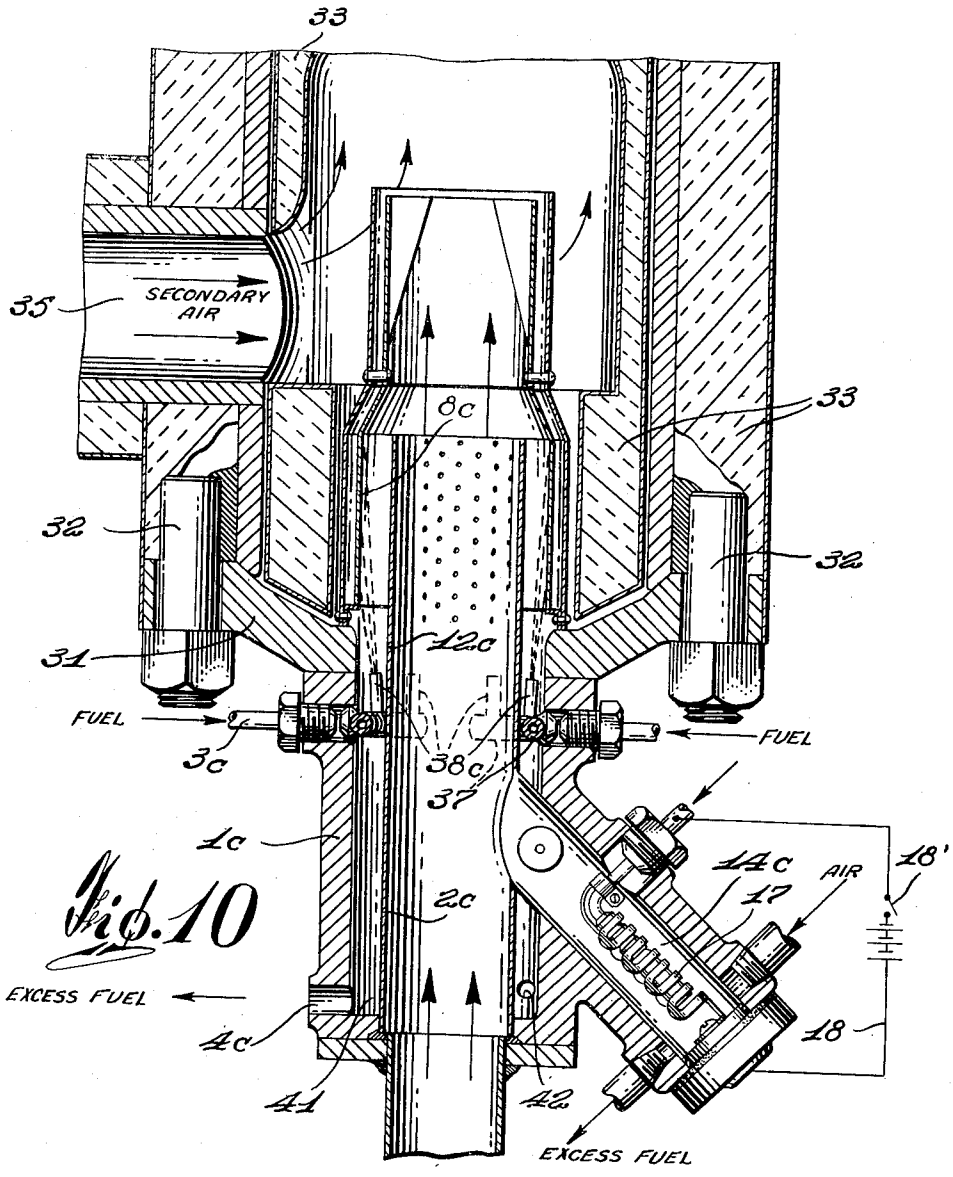

Fig. 10

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VAPORIZING OIL BURNER

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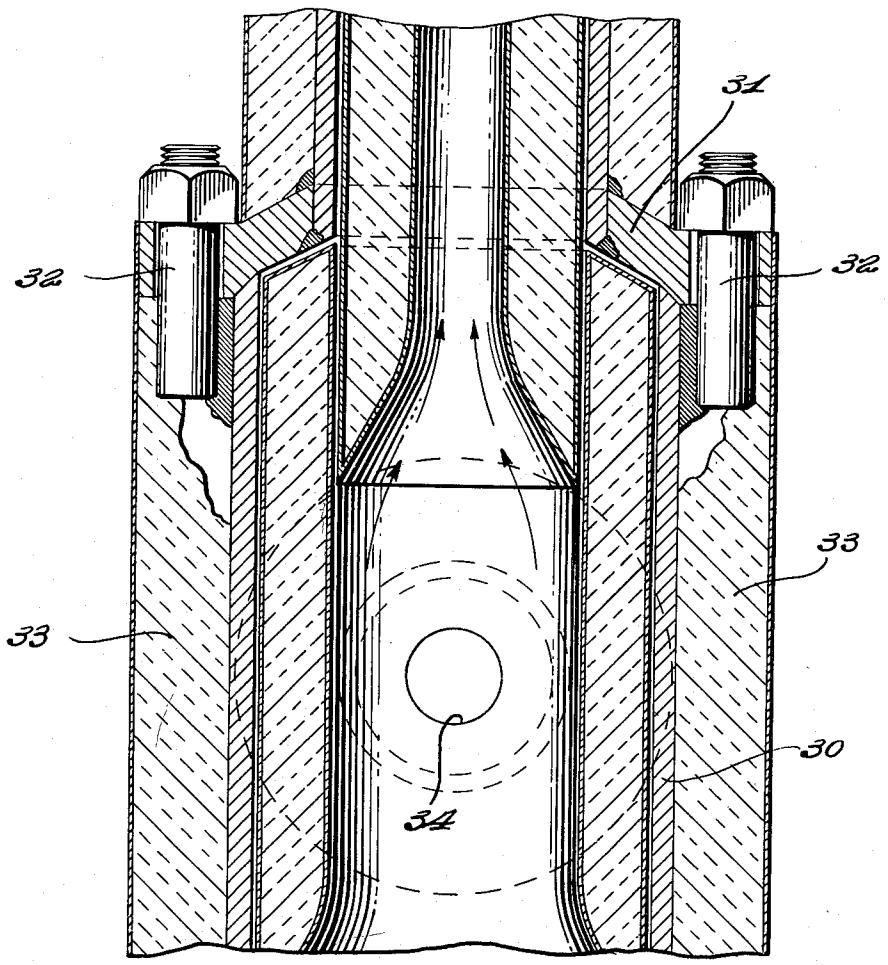

Fig. 11

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Patented June 20, 1961

2,988,887

VAPORIZING OIL BURNER

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Filed Sept. 26, 1956, Ser. No. 612,218
6 Claims. (Cl. 60—39.71)

This invention relates to vaporizing oil burners. Its purpose is to provide an improved arrangement of burner elements which is applicable to all classes of burner service.

In one class of vaporizing oil burners known as the "Pot Type," use for domestic heating, the combustion is started by applying incandescent heat directly to the liquid fuel; the more volatile constituents of the oil are vaporized and ignited by the heat, but the less volatile constituents are "cracked," liberating free carbon which is not so readily ignited and a smoky flame results; this condition exists during the lighting and operation at relatively low heat, when the flame is in direct contact with the surface of the liquid fuel. In this type of burner, the flame leaves the surface of the oil only when the combustion rate is increased by supplying fuel and air at a higher rate. At the maximum rate of combustion, the flame is out of contact with the vaporizing parts and the flame affects these parts only by heat radiated through space in a straight line; the cross-section of the aperture through which the radiated heat can pass, limits the flow of such heat from the flame to the vaporizing parts; any further increase in the flow of fuel and air to the flame cannot increase the flow of radiated heat and the rate of vaporization.

Another class of vaporizing oil burners is exemplified by kerosene blow torches; in such burners the fuel is vaporized fuel flowing out through a fine orifice at the end of the tube, there mixing with atmospheric air, the mixture being projected into the flame by the velocity of the vapor. In such burners, the flame is subject to pulsation occasionally, due to the relatively quick transfer of the flame-heat through the thin wall of the tube to the fuel; any fortuitous variation in the flame or its contact against the tube, causes a corresponding increase or decrease in the rate of vaporization and supply of vapor to the flame, with resulting pulsations. Following the manufacturer's printed instructions, the skilled workman can stop the pulsations when they occur and such burners accomplish their purpose. However, burners using coiled fuel vaporizing tubes, requiring such manual adjustment to stop pulsation, are not suitable for general heating service.

There is another feature of coiled tube vaporizing burners which prohibits their use in combustion chambers in which there is a substantial pressure above atmosphere, such as in oil-burning turbines or external combustion piston engines. Tests with the latter have shown that the flame from a coiled-tube vaporizing burner is extinguished when the pressure in the combustion chamber is raised from atmospheric pressure to the operating pressure of the engine, as is necessary when starting the engine. This extinction of the flame is due to the momentary interruption of the flow of vapor out of the tube-orifice when the surrounding pressure is raised, backing up the vapor into the tube.

With any type of vaporizing burner, when starting the burner from a cold condition, it is necessary to preheat the vaporizing member to vaporizing temperature before it will begin to vaporize and start operation of the burner.

In some classes of service, such as external combustion engines, it is essential to accomplish such preheating and starting of the operation, in the shortest possible time, such as one or two minutes. This requires a vaporizing member of the smallest practical weight. The vaporizing capacity ofthe burner is proportional to the area of vaporizing surface. Thus the weight of the vaporizing member cannot be reduced without sacrificing its vaporizing capacity. Hence design must be such as to provide a vaporizing member of minimum weight in relation to the required area of vaporizing surface.

The invention is not intended as apparatus for burning highly volatile fuel such as gasoline or kerosene; its field of application is in the burning of liquid fuel of the class commonly term "fuel oil," of which there are several grades. Each grade of fuel oil consists of hydrocarbon compounds of differing degrees of volatility; the more volatile constituents require only relatively low temperature to vaporize; the less volatile constituents require higher vaporizing temperature. Also certain grades of fuel oil contain some "free carbon," that is, carbon molecules not chemically combined with the hydrogen. Such "free carbon" being in a solid state, though extremely fine, will not vaporize, but can be carried in suspension in the vapor of the volatile constituents, under favourable conditions; thus such free carbon can be carried by the vapor into the air stream and into the flame and be burned.

If a vaporizing burner has a vaporizing member in the form of a vessel in which the liquid fuel is contained in some depth, then the portion of liquid fuel which is in direct contact with the metal surface of the containing vessel, will obviously be heated to a higher temperature than the interior portions of the liquid; it will be vaporized forming bubbles which rise to the surface; the bubbles will consist mainly of the more volatile constituents leaving the less volatile constituents in the liquid, to concentrate and form a residue which will be deposited on the bottom surface of the vessel; which will interfere with operation. Also there is a loss of the heat value of the unburned deposit of carbon.

Experience in testing of vaporizing burners has shown that such "cracking" of the fuel oil can be avoided only by providing the following features in the apparatus: The vaporizing member must have a metallic vaporizing surface initially heated to a temperature sufficiently high so that all of the constituents of the fuel oil will be vaporized instantly on contact with the vaporizing surface; thus the free carbon will also be carried with the vapor. The fuel oil must be applied to the vaporizing surface in the form of a very thin film, and applied only after the surface has been initially heated to vaporizing temperature. A stream of air must flow alongside of the vaporizing surface, as close as practical thereto, so that the vapor, on leaving the vaporizing surface need travel only a very short distance to reach and mix with the air; and the combustible mixture must travel only a minimum distance to enter the flame. The air stream must not actually contact the vaporizing surface, because the flame would then start at the liquid surface of the film of oil and cause smoke; also because the air stream would cool the vaporizing surface. In order to maintain such separation of minimum distance, a metallic screen must be provided, having a large number of small closely spaced perforations, for the passage of the vapor into the air stream. The thickness of the screen must be a minimum, in order to provide a minimum of contact of vapor (with free

carbon). Longer contact would cool and condense the vapor, causing a deposit.

It is the object of the present invention to overcome the limitations of other types of burners hereinbefore discussed and to provide the features necessary for successful performance as above outlined.

Accordingly, there is provided in the burner a combination of elements for supplying heat to the vaporizing surface, while at all times, even during ignition, preventing the flame from coming into direct contact with the unvaporized fuel. For this purpose, the heat from the flame is received by members positioned in the path of the flame and this heat is transferred to a vaporizing surface by heat conducting means. The heat transferred by this method is even, and the action of the vaporizing surface is not affected by fluctuations of the flame and thereby pulsation of the flame is avoided.

The ignition is obtained by separate vaporizing means, which become inoperative when the vaporizing surface has attained the appropriate temperature.

The invention will be more clearly understood in connection with the accompanying drawings in which:

FIGURE 1 is a sectional plan view taken on line **1—1** of FIGURE 2 of an embodiment of the invention;

FIGURE 2 is a longitudinal sectional elevation taken on line **2—2** of FIGURE 1;

FIGURE 3 is a partial cross-sectional elevation taken on line **3—3** of FIGURE 1;

FIGURE 4 is a plan view, partly in section, of another embodiment of the invention, the part in section being taken on line **4—4** of FIGURE 5;

FIGURE 5 is a longitudinal sectional elevation taken on line **5—5** of FIGURES 4 and 6;

FIGURE 6 is a cross-sectional elevation taken on line **6—6** of FIGURE 5;

FIGURE 7 is an elevation, partly in section, of the fuel diffuser shown in FIGURES 5, 6, 9 and 10;

FIGURE 8 is a development of the electric heating element, as it is cut from sheet metal, before it is rolled into the cylindrical shape shown in FIGURES 5, 6 and 9;

FIGURE 9 is a longitudinal section of the lower part of still another embodiment of the invention;

FIGURE 10 is a longitudinal section of the lower part of still another embodiment of the invention; and

FIGURE 11 is a longitudinal section of the upper part of FIGURES 9 and 10.

In the drawings like characters indicate like elements throughout, and similar elements in the various embodiments are indicated by like numerals followed by different letters.

Referring to the drawings, the burner of FIGURE 1 comprises a housing **1** which encloses a tubular air conduit **2**, the direction of the air flow being shown by arrows in FIGURE 2. The housing **1** has attached to it, by conventional means, a fuel supply duct **3**, a fuel drain duct **4**, a spray nozzle **5** adapted to supply vaporized fuel into the air conduit **2**, and spark electrodes **6** positioned near the mouth of said nozzle. Extending longitudinally in the direction of the air flow is an open housing **7** which contains, slightly spaced from it, the vaporizing surface **8**, connected by a heat conducting extension **9** to members **10**, which are positioned at an angle in the path of the flame as directed by the air flow in the conduit **2**. The heat conductor **9** comprises upwardly extending arms **11** also adapted to receive the heat of the flame. The heat conductor **9** is preferably made of copper. The vapourizing surface **8** is separated from the zone of the flame by a perforated cover plate **12**, which prevents direct contact between the flame and the vaporizing surface. Fuel is supplied to the vaporizing surface by duct **3**, and the excess of fuel is removed by the drain **4**. Means (not shown) are provided to return the drained fuel to the main supply line.

The operation of the burner is as follows:

Initially, the nozzle **5** provides the spray of liquid fuel which is ignited by spark electrodes **6**. The air stream in the air conduit **2** directs the flame in a substantially horizontal longitudinal direction so that the members **10** are heated. Heat is conducted from the members **10** through the heat conductor **9** to the vaporizing surface **8**. Fuel supplied to this surface is vaporized and passes as a vapor through the perforations of the cover **12**, mixing with the air of the conduit, thereby further feeding the flame. Thereafter, fuel flow from the nozzle **5** is shut off and the sparks from electrodes are stopped.

The embodiment of FIGURES 4, 5 and 6 comprises a housing **1*a***, air conduit **2*a*** with a threaded opening at one end for attaching an air supply pipe, and fuel supply duct **3*a***; said elements are similar to those of FIGURES 1, 2 and 3. The corresponding housing **7*a***, containing the vaporizing surface **8*a*** with cover **12*a***, the members **10*a***, and heat conductor **9*a***, has a cover **13** above the vaporizing surface. The members **10*a*** are upright rods.

The spray nozzle of the first embodiment is here replaced by an auxiliary vaporizing apparatus, positioned in a separate chamber **14** at right angles and connected to the main air conduit **2*a***. This apparatus comprises a fuel tube **15**, perforated in its lower portion, the perforated portion being covered by rings **16** of porous material, such as slate, through which the liquid fuel is diffused. A detail of this diffuser is shown in FIGURE 7. The rings are bevelled on their upper edges to provide an increased surface. The diffuser is surrounded by an electrical element **17**, cut from sheet metal, as shown in FIGURE 8, to provide a substantial length of path for the electric current, and rolled into a cylindrical shape. An electric battery circuit **18**, switch **18′** and connectors **19** and **19′** are provided; one terminal of the battery is electrically connected to the upper end of said heating element **17**, through connector **19**, plate **20**, bushing **21** and fuel tube **15**, these latter parts being in electrically conductive contact with the housing **1*a***. The other terminal of the battery is electrically connected to the lower end of the heating element **17** through the connector **19′**, plate **20′** and the cover **21′**, said cover being insulated from the housing **1*a*** and the bolts **24** by means of insulating washers **23**, gasket **23′** and insulating sleeves **25** and **25′**, as shown in FIGURES 5 and 6. An air inlet **26** and an excess fuel drain **27** are provided at the bottom of the vaporizing chamber **14**, said inlet and drain being threaded for attaching suitable pipes and spark electrodes **6*a*** are positioned near the intersection of chamber **14** and air conduit **2*a***. The operation of the burner of this embodiment is the same as that of the burner in the first embodiment, with the exception, of course, that the initial vaporized fuel is supplied by the combination of the diffuser and the heating element in the chamber **14**.

Accordingly, when starting the burner, the switch **18′** in the circuit **18** is closed, and the element **17** reaches vaporizing temperature in about 15 seconds. Then fuel flow is started through the perforated fuel tube **15**, radially outward through the diffuser **16** and into contact with the element **17**. The flow of air through air inlet **26** brings the vaporized fuel into the zone of the spark electrodes **6*a*** and a flame is produced. The excess of unvaporized fuel flows out through the drain **27**. The remainder of the operation is the same as that described above.

In FIGURES 9 and 10 are shown burners adapted to operate under relatively high pressure above atmospheric as e.g. in connection with external combustion engines. Hence the burners are contained in a pressure vessel having cylindrical steel walls **30**, with ends **31** attached thereto by bolts **32**, which are welded to the wall **30**. Heat insulation **33** is provided inside and outside the walls. The internal insulation limits the temperature of the steel to a value providing safe tensile strength. The burners extend upwards, as shown in FIGURE 11, wherein the bottom break line corresponds to the top break

line of both FIGURES 9 and 10. A side outlet **34** may be provided in the upper part of the vessel (FIGURE 11) to obtain interchange of combustion products if several burners are used to serve one engine having several cylinders. A secondary air inlet **35** is shown in FIGURES 9 and 10.

In FIGURE 9, the burner proper comprises an air conduit **2***b* positioned vertically, and a vaporizing chamber **14***b* of the same type and containing the same elements of the chamber **14** of the second embodiment. Said chamber is in upwardly inclined position, and spark electrodes **6***b* are provided at its upper end. The vaporizing surface **8***b* and the heat conductor **9***b* are formed of an integral cylindrical tube comprising a frusto conical portion **11***b* near its center. The members **10***b* in the path of the flame have the shape of radial fins. Said cylindrical tube **8***b*—**9***b*—**11***b* is enclosed by a similar larger tube **7***b*, and is spaced therefrom. A cylindrical perforated screen **12***b* is provided between the zone containing the flame and the vaporizing surface. A flange **36**, at right-angles to the cover plate, is provided at its upper end, and an inclined flange **36'** is provided at its lower end. The fuel supply duct **3***b* extends into semi-circular tube portions **37** connected to the casing, and to the outside by conventional means, and carrying a plurality of upwardly extending tubes **38**, the upper extremities **39** of which are bent into contact with the vaporizing surface **8***b*, and are thus adapted to pour liquid fuel onto said surface. If fuel is deposited on the surface faster than it can be vaporized, the excess of fuel runs through the cuts **40** in the lower flange **36'** of the screen **12***b*, down the wall **1***b* of the air conduit **2***b*, over a ring **43** and out through the fuel drain **4***b*.

The embodiment of FIGURE 10 is similar to that of FIGURE 9, with the exception that the upwardly extending fuel supply tubes are replaced by nozzles **38***c* adapted to spray liquid fuel onto the vaporizing surface **8***c*; and that perforated cylindrical screen **12***c* extends downwardly to form an air conduit **2***c* connected to an air inlet at the lower end of the burner. Here also the excess of unvaporized fuel flows down the internal wall **1***c* of the housing, and gathers in the annular zone **41** at the bottom of the space between said housing **1***c* and said air conduit **2***c*. A stream of air is supplied intermittently from an inlet **42** to force said fuel out through the fuel drain **4***c*. The operation of the last two embodiments, shown in FIGURES 9 and 10, is the same as that of the burner of FIGURES 4 to 6.

While several embodiments of the invention have been described and illustrated, the invention is not limited thereto but may take any form within the spirit and scope of the appended claims.

I claim:

1. An apparatus for burning liquid fuel, comprising a metallic fuel vaporizing member, a metallic heat-absorbing member connected in heat conducting relation to said fuel-vaporizing member, said members having a large surface area in relation to their weight, means for producing an initial preheating flame in contact with said heat-absorbing member, whereby said fuel-vaporizing member is initially heated to fuel-vaporizing temperature, means for thereafter applying a thin film of said fuel over the vaporizing surface of said fuel-vaporizing member, whereby said film of fuel is vaporized, a sheet metal screen separated from said vaporizing surface by a space small in relation to the dimensions of said vaporizing surface, said screen being pervious to the passage of fuel-vapor, said fuel-vapor being free to flow from all parts of said vaporizing surface directly across said small space, through said screen, and an air passage adapted to convey a current of air along a face of said screen, said screen being located between said vaporizing surface and said air stream, thereby producing a stream of combustible mixture of air and fuel-vapor which flows into said initial preheating flame which ignites said combustible stream, thereby establishing a flame in contact with said heat-absorbing member and maintaining the fuel-vaporizing temperature of said fuel-vaporizing member, after the production of said initial preheating flame has been stopped; wherein said means for producing an initial preheating flame include a vaporizing liquid fuel burner comprising a perforated fuel supply tube, a liquid-pervious cover enclosing said tube providing an outer surface adapted to retain a film of said liquid fuel, an electric heating element partially enclosing said pervious cover in close proximity thereto, adapted to vaporize said fuel, an air conduit enclosing said electric heating element substantially concentric with said pervious cover, an air-inlet adapted to admit a flow of air into said conduit, thereby producing a current of air mixed with fuel-vapor in said conduit, and ignition means adapted to ignite said stream of combustible mixture.

2. An apparatus as claimed in claim 1 wherein said last-named air conduit is connected to said first-named air passage whereby a preheating flame is delivered to said heat-absorbing member.

3. An apparatus as claimed in claim 2 wherein said last-named air conduit has an outlet at its lower end providing gravitational outflow of excess fuel.

4. In an apparatus for the combustion of liquid fuel, a tubular metallic structure having an inlet end and an outlet end, means for initially heating said structure to fuel-vaporizing temperature, means for thereafter applying a thin film of liquid fuel into contact with the inner surface of said tubular structure adjacent the inlet end thereof, whereby said heated surface vaporizes said liquid fuel and emits said vapor inwardly toward the axis of said tubular structure, a tubular screen of sheet metal within the fuel-vaporizing portion of said tubular metallic structure, said screen being closely spaced in relation to said enclosing tubular metallic structure, said screen having perforations adapted to pass said fuel vapor from said vaporizing surface, through said perforations into the interior of said tubular screen, means for conducting a current of air along the interior of said tubular screen, thereby mixing said air with said fuel vapor, means for igniting said combustible mixture of air and vapor, thereby producing a flame, said flame passing through the outlet end of said tubular metallic structure while making contact therewith, thereby transferring heat to said tubular metallic structure and said vaporizing surface and maintaining the fuel-vaporizing temperature thereof, said means for initially heating said structure comprising a vaporizing liquid fuel burner consisting of a perforated fuel supply tube, a liquid pervious cover enclosing said tube providing a vaporizing surface, an electrical heating element partially enclosing said cover, an air duct enclosing said heating element, said fuel supply tube and said cover and communicating with said tubular structure at its inlet end, said air duct adapted to produce a combustible air-fuel mixture and to direct said mixture into said tubular structure, and ignition means igniting said mixture.

5. In an apparatus as claimed in claim 4, said cover being adapted to allow gravitational out-flow of excess fuel.

6. In an apparatus for burning liquid fuel, comprising a metallic fuel-vaporizing member; means for initially preheating said vaporizing member, said preheating means comprising a vaporizing liquid fuel burner having a perforated fuel-supply tube, a liquid-pervious cover enclosing said tube providing an outer surface adapted to retain a film of said liquid fuel, an electric heating element partially enclosing said pervious cover in close proximity thereto, adapted to vaporize said film of fuel, an air-conduit enclosing said electric heating element, substantially concentric with said pervious cover, an air-inlet adapted to admit a flow of air into said conduit, thereby producing a current of air mixed with fuel-vapor in said conduit, and

ignition means adapted to ignite said stream of combustible mixture.

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